Ontario

Ministry of the Environment

Water Resources Report 14

+ 14 MAPS

Hon. Keith C. Norton, *Minister*
Graham W. S. Scott, Q.C., *Deputy Minister*

Thames River Basin Water Management Study Technical Report

Ground-Water Resources

Additional copies of this report and other reports in the 'Water Resources Report' series may be obtained in person from the Ontario Government Bookstore, 880 Bay Street, Toronto, Ontario, or by mail from the Ontario Government Publications Centre, 5th Floor, 880 Bay Street, Toronto, Ontario, M5S 1Z8.

ISSN 0475-0942
ISBN 0-7743-6268-5

WATER RESOURCES REPORT 14

Contents

Ontario

WATER RESOURCES REPORT 14

Thames River Basin Water Management Study Technical Report

Ground-Water Resources - Summary

By
K. Goff and D. R. Brown

MINISTRY OF THE ENVIRONMENT
Water Resources Branch

Toronto Ontario

1981

INTRODUCTION

Ground water in the Thames River basin is a valuable and critical resource. This important agricultural area depends to a large extent on wells for its farm, domestic, commercial, industrial and municipal water supplies. With a growing concern for the availability and security of water supplies in southern Ontario, it has become even more important to inventory and study this resource.

The compilation and evaluation of ground-water data for the Thames River basin began in 1971 as part of a comprehensive water management study in the basin. During 1972 and 1973, nineteen test holes were drilled in order to study the detailed lithology of overburden aquifers in Middlesex and Oxford counties. This program included electric logging, split-spoon sampling and grain-size analyses. In addition, in 1973 chemical analyses were conducted on samples from 135 wells in the basin.

This report presents maps showing the distribution, quality and availability of ground water in the basin, as well as surficial and bedrock geology and the locations of water wells used in the study. The maps, with brief descriptive notes, are presented on sheets as follows:

Sheet 1. Physiography and Surface Geology
Sheet 2. Upper Thames River - Locations of Water Wells
Sheet 3. Lower Thames River - Locations of Water Wells
Sheet 4. Upper Thames River - Bedrock Aquifers
Sheet 5. Lower Thames River - Bedrock Aquifers
Sheet 6. Upper Thames River - Shallow Overburden Aquifers
Sheet 7. Upper Thames River - Intermediate Overburden Aquifers
Sheet 8. Upper Thames River - Deep Overburden Aquifers
Sheet 9. Lower Thames River - Shallow Overburden Aquifers
Sheet 10. Lower Thames River - Intermediate Overburden Aquifers
Sheet 11. Lower Thames River - Deep Overburden Aquifers
Sheet 12. Ground-Water Quality
Sheet 13. Well Logs

ACKNOWLEDGEMENTS

The bulk of this study was carried out under the supervision of Mr. K. Goff, Groundwater Evaluator and Chief of Water Resources of the Southwestern Region until 1979. Final compilation, descriptive notes and study summary were done by his successor as Groundwater Evaluator, Mr. Dan Brown. The comments and editorial recommendations of Mr. U. Sibul, Water Resources Branch are gratefully acknowledged.

Special thanks are due Mr. R. Rae, Mr. C. MacRae and other staff who assisted in the compilation of data for the study.

SUMMARY

The Thames River basin covers an area of approximately 5,830 square kilometres, extending about 200 kilometres from the river's headwaters in Oxford and Perth counties to its mouth at Lake St. Clair near Tilbury. The topography is relatively flat as the Thames River drops roughly 170 metres over its length, an average of .85 metres per kilometre.

The surficial geology of the basin (Sheet 1) is primarily the result of materials deposited and moulded by the last continental glaciers and by their meltwaters some 10,000 years ago. The major features are large till, sand and clay plains which are broken locally by terminal moraines and by the sand-covered valleys of the Thames River and its tributaries.

Sheets 2 and 3 provide the locations of all water wells used as sources of hydrogeologic data in the mapping of aquifers indicated on the respective sheets. Only water well records available to September 1973 were used and, in areas of high well densities, only selected wells were plotted.

The bedrock aquifers mapped on sheets 4 and 5 were delineated on the basis of the geologic map prepared by Sanford (1969). These aquifers are important throughout the Thames River basin, but particularly in the upper part of the basin where Middle Devonian limestones and dolomites are exploited for large quantities of good quality ground water. In the lower part of the basin, subcropping bedrock consists primarily of shales and both ground-water quality and well yields are poorer.

Sheets 6, 7 and 8 demonstrate the extent of overburden aquifers in the upper part of the basin. In this region, the bedrock is buried typically by 30 to 60 metres of overburden materials which commonly include one or more sand and/or gravel deposits. These units provide ground water to domestic, commercial, agricultural, industrial and municipal wells in quantities of up to several tens of litres per second. While shallow aquifers such as those on the Caradoc Sand Plain are susceptible to surface contaminants and seasonal water-table fluctuations, the intermediate and deep units are normally well protected by overlying low-permeability deposits.

The overburden in the lower part of the Thames River basin is generally thinner and there are not as many overburden aquifers in this area (Sheets 9, 10 and 11) as in the upper part. However, the overburden aquifers are common sources of water because of inadequate supplies available from the bedrock. Major overburden aquifers are found in the central part of the area where the Bothwell Sand Plain forms a shallow aquifer that is underlain also by intermediate aquifers. Again, the shallow aquifers are particularly susceptible to both contamination and seasonal water-table fluctuations.

The natural ground-water quality concerns in the Thames River basin are shown on the maps of Sheet 12. These maps are based on the analyses of 135 water samples collected in 1973 and analyzed by the Ministry of the Environment. Hardness, iron and total dissolved solids (as shown by specific conductance) are the most common ground-water quality problems. In most cases these problems are not severe and are accepted by the consumer; often simple treatment by softening is the solution. Local problems with high chloride or hydrogen sulphide concentrations occur with supplies from bedrock and these are more troublesome and less easily dealt with.

Sheet 13 provides detailed logs and descriptions of nineteen test holes drilled in 1972 and 1973 in Middlesex and Oxford counties. Also included are the graphs of resistivity, self potential, gamma ray and caliper logs run as part of this study. These logs can all be used to better evaluate and delineate aquifers.

Apart from the lack of suitable supplies of ground water for industrial and municipal uses in some areas, the major ground-water concerns in the Thames River basin relate to the potential contamination and security of aquifers and individual wells. The major problems are with wells tapping the shallow aquifers on the Bothwell and Caradoc Sand plains. Wells in these areas are very susceptible to surface sources of contamination, and widespread contamination has resulted from private septic systems and in some cases from agricultural chemical fertilizers. Road salting, landfill sites and accidental hydrocarbon spills are also problems locally.

MINISTRY OF THE ENVIRONMENT

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 1

PHYSIOGRAPHY AND SURFACE GEOLOGY

Scale 1 200 000

LEGEND

Peat and muck

Sand and gravel

Drumlin

Geologic boundary, approximate

SOURCES OF INFORMATION

Generalized surficial materials compiled by Ken Goff, 1973, from cited references

Chapman, L.J. and Putnam, D.F., 1966. The physiography of southern Ontario. University of Toronto Press.

Cowan, W.R., 1971. Pleistocene geology of the Woodstock area, southern Ontario. Ontario Department of Mines and Northern Affairs, Preliminary Map P. 701.

Ontario Agricultural College. Soil survey map, County of Middlesex. Dominion Department of Agriculture and the Ontario Agricultural College, Soil Survey Report No. 6.

Richards, N.R., Caldwell, A.G. and Morwick, F.F., 1949. Soil survey of Essex County. Dominion Department of Agriculture and the Ontario Agricultural College, Report No. 11 of the Ontario Soil Survey.

DESCRIPTIVE NOTES

The physiography of the Thames River basin, like in most of southern Ontario, is the result of advances and retreats of continental glaciers that covered the area. The last, or Wisconsinan, glacier was responsible for depositing the variety of overburden materials shown on the map.

The silt and clay tills of the Stratford and Oxford Till plains cover a large part of the

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 2

UPPER THAMES RIVER
LOCATIONS OF WATER WELLS

Scale 1:100 000
1 inch equals 1.58 miles

LEGEND

DESCRIPTIVE NOTES

ELMA
MCKILLOP
MORNINGTON
WELLESLEY
BLANSHARD
DOWNIE
ZORRA
WEST ZORRA
NISSOURI
SOUTH OXFORD
EAST OXFORD
NORTH NORWICH
SOUTH EASTHOPE
Tavistock
Dorchester
WESTMINSTER
SOUTH DORCHESTER

ONTARIO

MINISTRY OF THE ENVIRONMENT

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 3

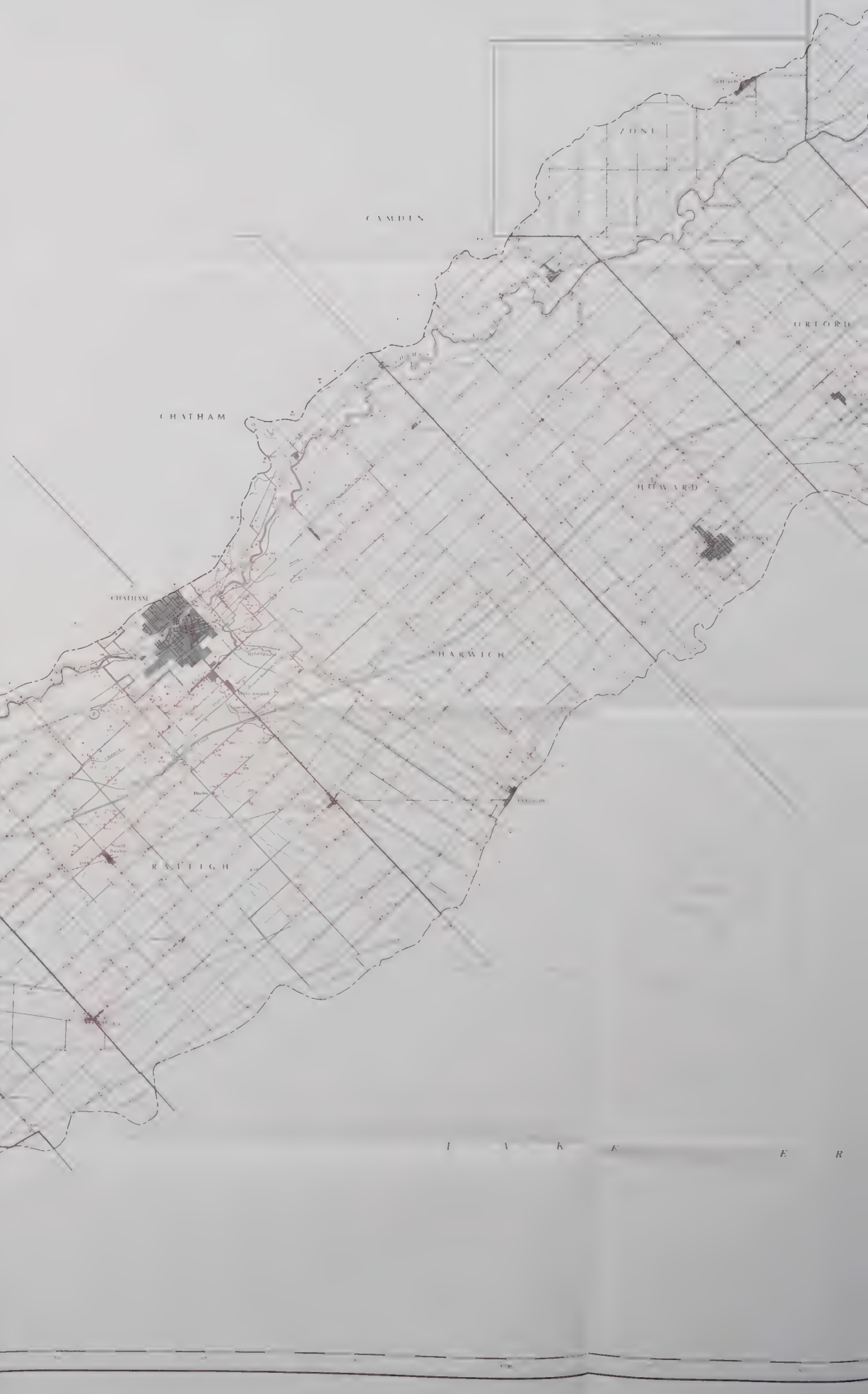
LOWER THAMES RIVER
LOCATIONS OF WATER WELLS

Scale 1:100,000
1 inch equals 1.58 miles

2 0 2 4 6
Miles

LEGEND

DESCRIPTIVE NOTES



DELAWARE

CARADOC

ESSEX

MOSA

DENWICH

ZONE

CAMDEN

ALDBOROUGH

ORFORD

HOWARD

HARWICH

Blenheim

L A K E E R I E

MAP 2727-3

Ontario
MINISTRY OF THE ENVIRONMENT

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 3

UPPER THAMES RIVER BEDROCK AQUIFERS

Scale 1:100 000

LEGEND

PALEOZOIC

DEVONIAN

MIDDLE DEVONIAN

Hamilton Group

Dundee River Group

LOWER DEVONIAN

SILURIAN

UPPER SILURIAN

SYMBOLS

SOURCES OF INFORMATION

DESCRIPTIVE NOTES

ELMA

McKILLOP

MORNINGTON

LOGAN

HIBBERT

BLANDFORD

LONDON

NORTH OXFORD

NORTH NORWICH

NORTH DORCHESTER

SOUTH DORCHESTER

Ontario

MINISTRY OF THE ENVIRONMENT

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 5

LOWER THAMES RIVER
BEDROCK AQUIFERS

Scale 1:100 000

LEGEND

PALEOZOIC

DEVONIAN

UPPER DEVONIAN

MIDDLE DEVONIAN

Hamilton Group

SYMBOLS

DESCRIPTIVE NOTES

SOURCES OF INFORMATION

Ontario

MINISTRY OF THE ENVIRONMENT

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 1:

UPPER THAMES RIVER
SHALLOW OVERBURDEN AQUIFERS

Scale 1:100 000

1 inch equals 1.58 miles

LEGEND

SYMBOLS

DESCRIPTIVE NOTES

SOURCES OF INFORMATION

ELMA

MCKILLOP

MORNINGTON

WELLESLEY

HIBBERT

FULLER

NORTH EASTHOPE

ELLARTON

SOUTH EASTHOPE

DOWNIE

ROYNSHEARD

STRATFORD

BLANDFORD

WEST ZORRA

EAST ZORRA

BLENHEIM

NISSOURI

EAST NISSOURI

EAST OXFORD

NORTH OXFORD

WEST OXFORD

NORTH NORWICH

NORTH DORCHESTER

SOUTH DORCHESTER

WESTMINSTER

CARADOC

MINISTRY OF THE ENVIRONMENT

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 7

UPPER THAMES RIVER INTERMEDIATE OVERBURDEN AQUIFERS

Scale 1:100 000

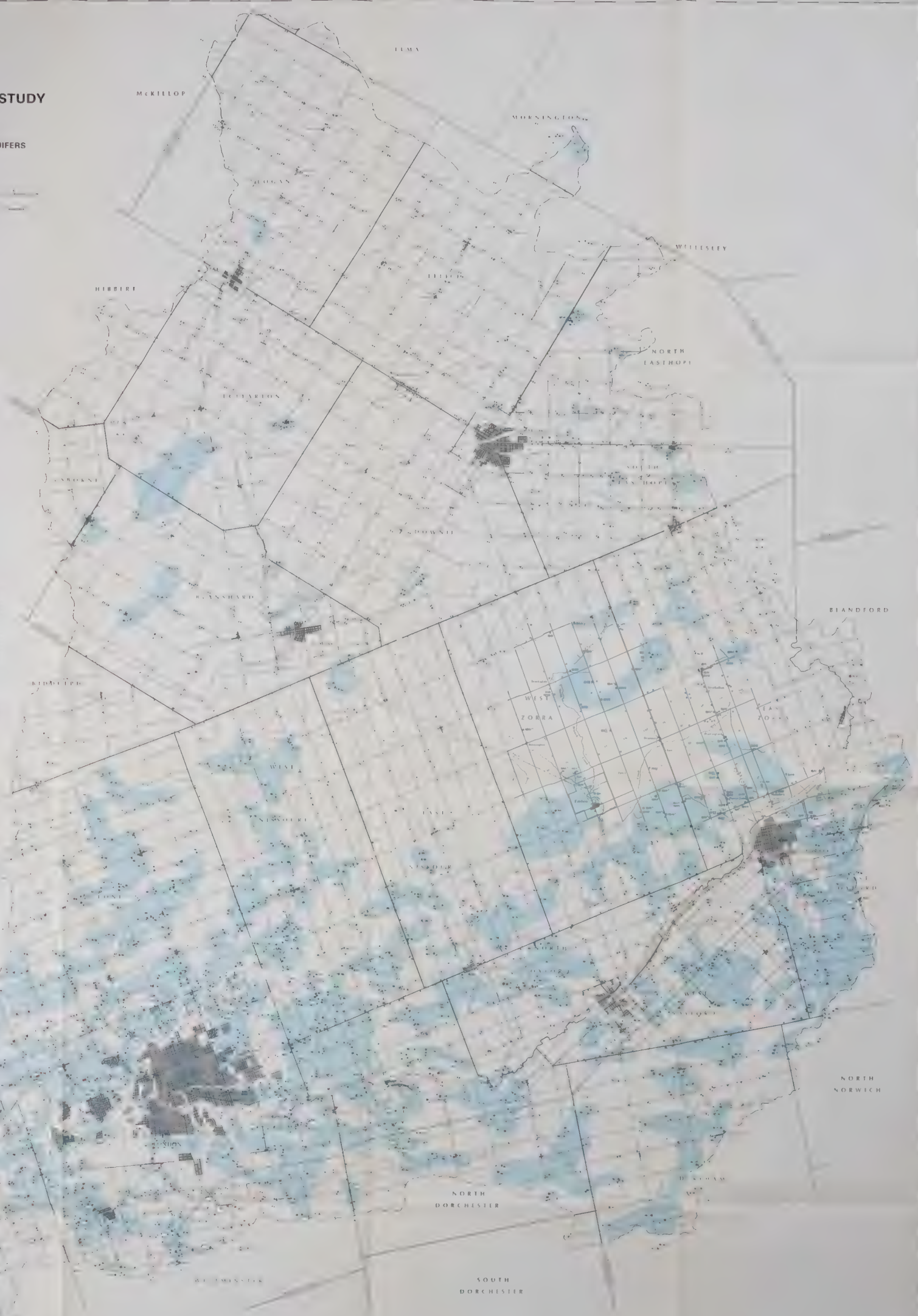
1 inch equals 1.58 miles

LEGEND

SYMBOLS

DESCRIPTIVE NOTES

SOURCES OF INFORMATION



MINISTRY OF THE ENVIRONMENT
WATER RESOURCES REPORT 14
THAMES RIVER BASIN STUDY
UPPER THAMES RIVER
DEEP OVERBURDEN AQUIFERS
Scale 1:100 000
LEGEND
SYMBOLS
DESCRIPTIVE NOTES
SOURCES OF INFORMATION
McKILLOP
MORNINGTON
HIBBERT
NORTH EASTHOPE
SOUTH EASTHOPE
FULLARTON
USBORNE
BLANSHARD
BLANDFORD
BIDDULPH
WEST ZORRA
EAST ZORRA
WEST NISSOURI
EAST NISSOURI
EAST OXFORD
NORTH OXFORD
WEST OXFORD
NORTH NORWICH
LONDON
NORTH DORCHESTER
SOUTH DORCHESTER
WESTMINSTER
DEREHAM

MINISTRY OF THE ENVIRONMENT

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 9

LOWER THAMES RIVER
SHALLOW OVERBURDEN AQUIFERS

Scale 1 100 000

LEGEND

SYMBOLS

DESCRIPTIVE NOTES

SOURCES OF INFORMATION

Ontario

MINISTRY OF THE ENVIRONMENT

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 10

LOWER THAMES RIVER
INTERMEDIATE OVERBURDEN AQUIFERS

Scale 1 100 000

1 inch equals 1.58 miles


DUNWICH
CAMDEN
ALDBOROUGH
HARWICH
LEGEND
SYMBOLS
DESCRIPTIVE NOTES
SOURCES OF INFORMATION

Ontario
MINISTRY OF THE ENVIRONMENT

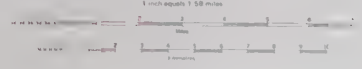
WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 11

LOWER THAMES RIVER
DEEP OVERBURDEN AQUIFERS

Scale 1:100,000
1 inch equals 1.58 miles



CAMDEN

ZONE

MONA

TASKIN

CARADOC

DUNWICH

ALDBOROUGH

ORFORD

HOWARD

BARWICH

LEGEND

SYMBOLS

DESCRIPTIVE NOTES

SOURCES OF INFORMATION

MAP 2727 37

Ontario

MINISTRY OF THE ENVIRONMENT

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 12

GROUND-WATER QUALITY

Scale 1:600 000

DESCRIPTIVE NOTES

Ground-water quality in the Thames River basin is illustrated by five parameters: hardness, chloride, specific conductance, total iron and sulphates. One map shows the locations and well record numbers for each well sampled. On each of the other maps the value of one parameter for each sample is plotted next to its location. Areas where values exceed the recommended limit for a parameter for drinking water are shaded.

When using these maps, it should be noted that the indicated concentrations apply for the particular aquifer indicated by the well symbols, and that water quality may be better or worse in another aquifer at the same location.

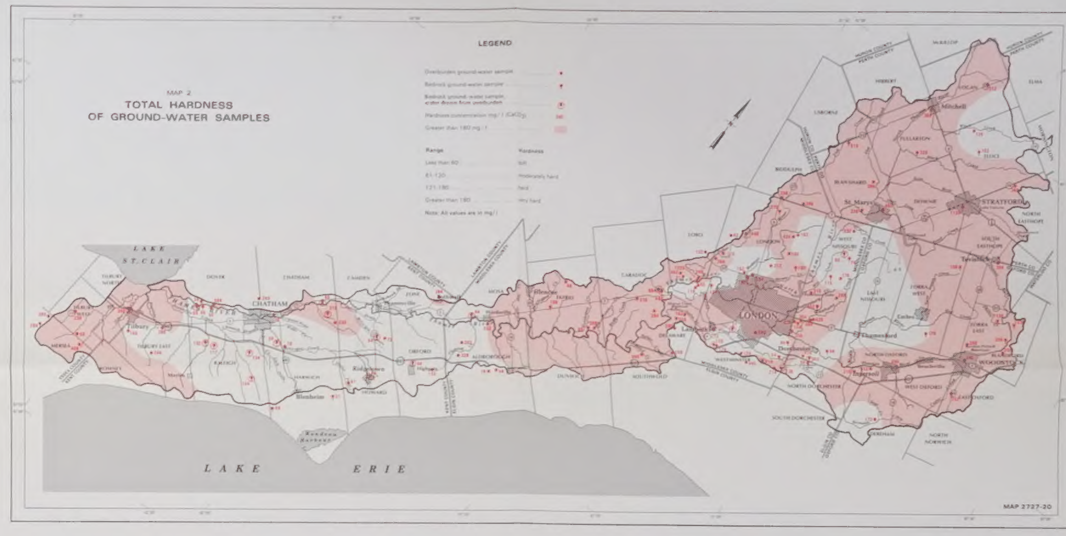
Ground-water hardness is a common problem in the Thames River basin, particularly in the upper part of the basin in bedrock aquifers. In the lower part of the basin the bedrock aquifers are primarily shales and hardness is generally not a problem.

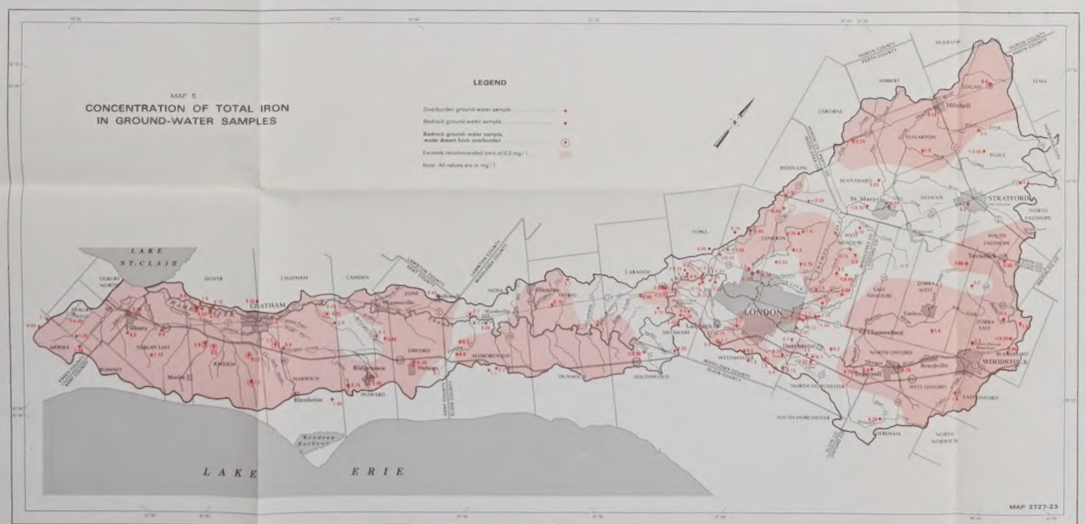
High concentrations of chlorides in ground water are not common in most of the basin. Background values of less than 10 mg/L are normal in the upper part. In the lower part of the basin, concentrations are generally higher, but only in the Merlin-Tilbury area do chlorides commonly exceed 250 mg/L.

Specific conductance of water provides an indication of its total dissolved solids content; the higher the conductance, the higher the total dissolved solids. Accordingly, the total dissolved solids are estimated to be relatively high in most ground-water samples in the basin.

Total iron concentrations in ground water are also commonly high, producing taste and staining problems in many domestic supplies. Most of the sampled wells show iron levels above the 0.3 mg/L recommended limit for potable supplies.

Sulphate in ground water is generally not a problem in the basin. Only very locally do values exceed the 250 mg/L recommended limit for drinking water.





Ontario

MINISTRY OF THE ENVIRONMENT

WATER RESOURCES REPORT 14

THAMES RIVER BASIN STUDY

SHEET 13

WELL LOGS

DESCRIPTIVE NOTES

In order to show detailed lithology and water-bearing characteristics of aquifers, numerous test holes were drilled (during the study) in Middlesex and Oxford counties in the upper part of the Thames River basin.

Detailed geologic logs of all the major overburden and bedrock units are given for each well, as well as the grain-size distributions for split-spoon samples collected at various depth. To further evaluate the physical properties of each unit and to confirm the geologic logs, resistivity, self potential, gamma-ray and caliper logs were also run off for most test holes. This information is useful in the design and construction of a well to obtain the optimum yield and water quality from it. In all logs, an increase in value occurs to the right.

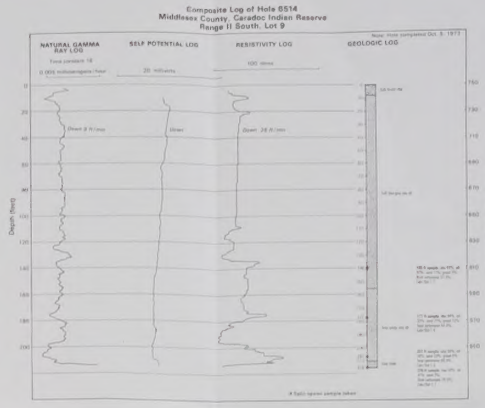
The resistivity log is probably the most common electric log used in aquifer evaluations. Assuming that ground-water quality remains relatively constant, sand and gravel units can be differentiated from silt and clay units because of their characteristically higher resistance to an induced current. Given a choice between two or more potential sand aquifers for completion of a well, the driller would normally choose the one with the highest resistivity value, which indicates a cleaner, more permeable material.

The self potential log also measures an electrical property of materials intersected by a test hole. Sands, for example, are typified by low voltages and clays by higher voltages.

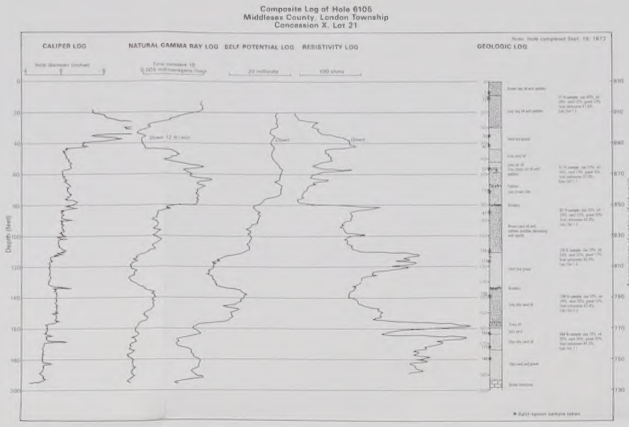
The gamma ray log is a measure of the natural gamma radiation emitted by particles in overburden or bedrock. Clays and shales typically emit high levels of gamma radiation, while sand and limestone emissions are lower. For the development of overburden aquifers, the coarse-grained unit with the lowest gamma count would normally be chosen, as this would indicate the lowest clay content and also the most permeable material.

The caliper log is a measure of the borehole diameter after drilling. Because of the tendency of loose, more permeable overburden materials to collapse into the open hole, this method can be used to help identify such units. In the bedrock, more friable or fractured units produce a large-diameter hole, thus indicating good water production potential.

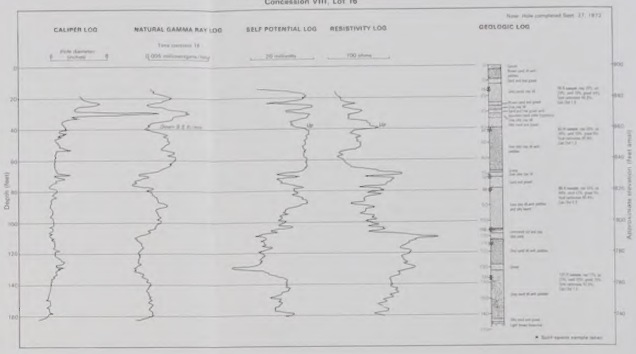
Composite Log of Hole 6514
Middlesex County, Caradoc Indian Reserve
Range II South, Lot 9



Composite Log of Hole 6105
Middlesex County, London Township
Concession X, Lot 21

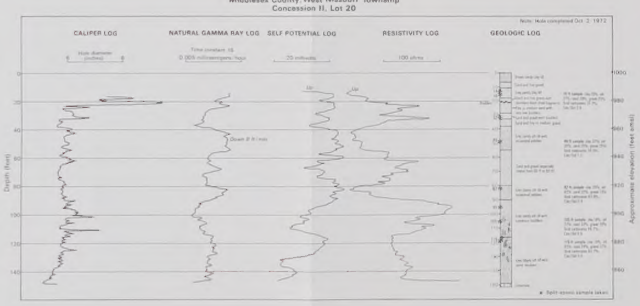


Composite Log of Hole 6107
Middlesex County, London Township
Concession VIII, Lot 16

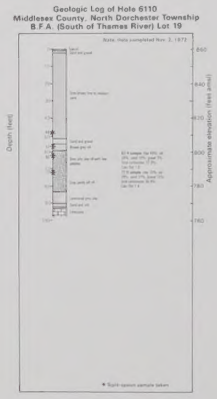


Geologic Log of Hole 6109
Middlesex County, West Nissouri Township
Concession II, Lot 11

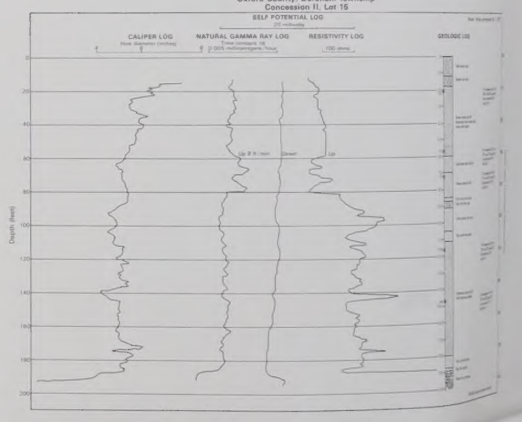
Composite Log of Hole 6108
Middlesex County, West Nissouri Township
Concession II, Lot 20



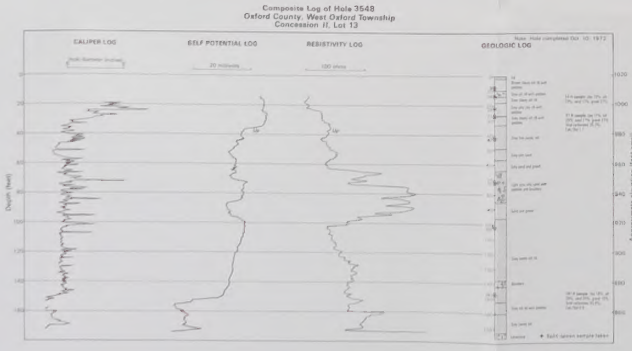
Geologic Log of Hole 6110
Middlesex County, North Dorchester Township
B.F.A. (South of Thames River) Lot 19



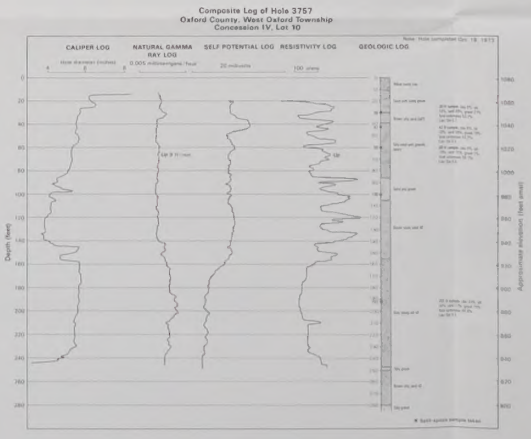
Composite Log of Hole 3762
Oxford County, Dereham Township
Concession II, Lot 15

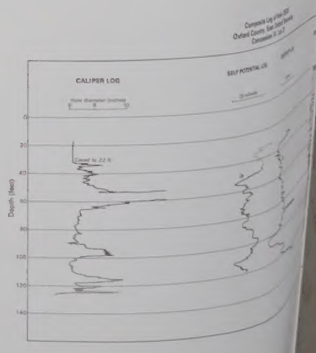


Composite Log of Hole 3548
Oxford County, West Oxford Township
Concession II, Lot 13

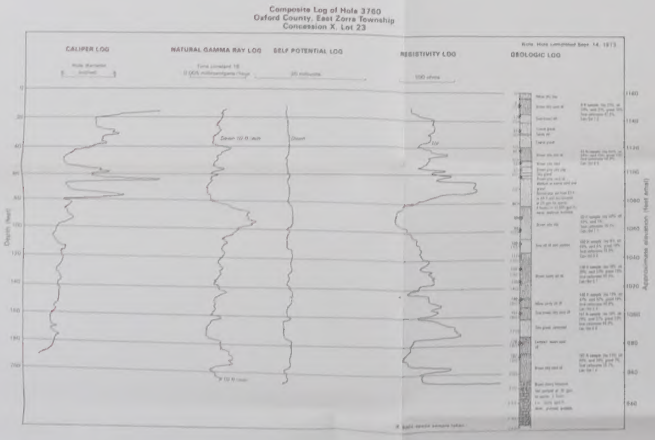


Composite Log of Hole 3757
Oxford County, West Oxford Township
Concession IV, Lot 10

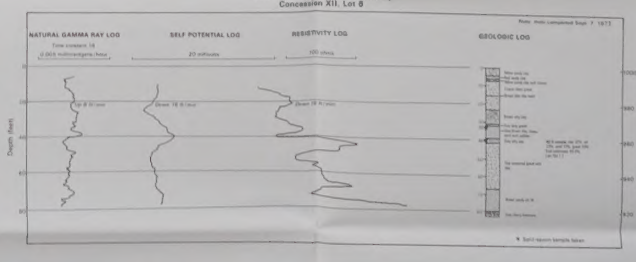


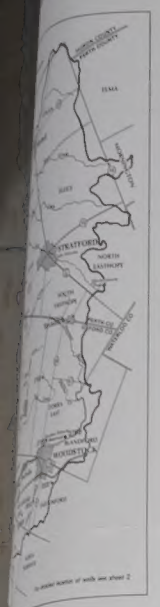


Composite Log of Hole 3760
Oxford County, East Zorra Township
Concession X, Lot 23

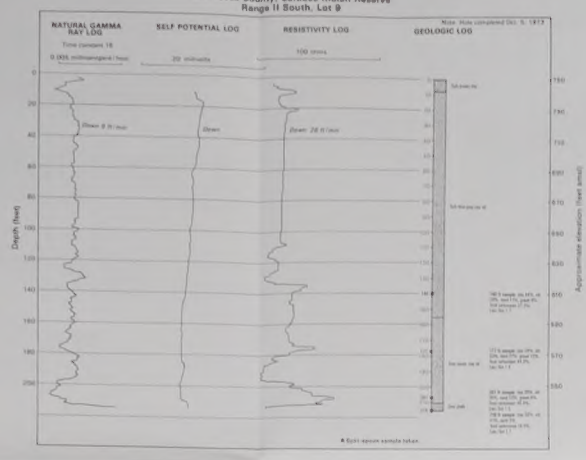


Composite Log of Hole 3759
Oxford County, East Zorra Township
Concession XII, Lot 8

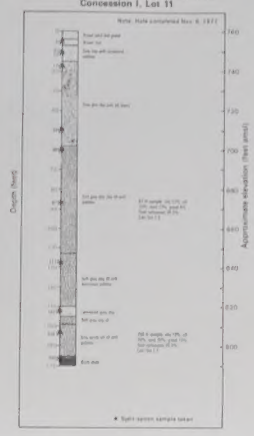




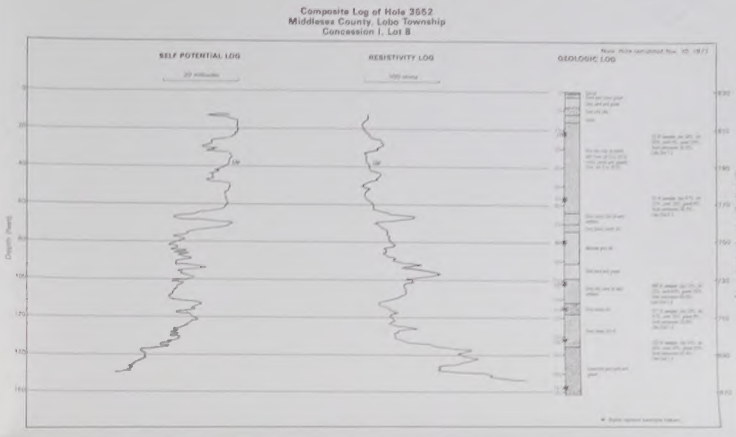
Composite Log of Hole 6514
Middlesex County, Caradoc Indian Reserve
Range II South, Lot 9

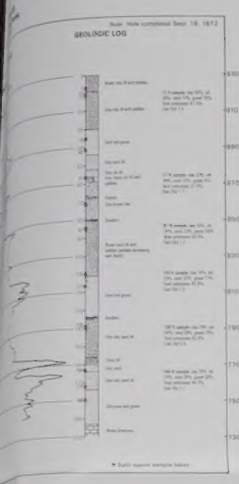


Geologic Log of Hole 6111
Middlesex County, Delaware Township
Concession I, Lot 11

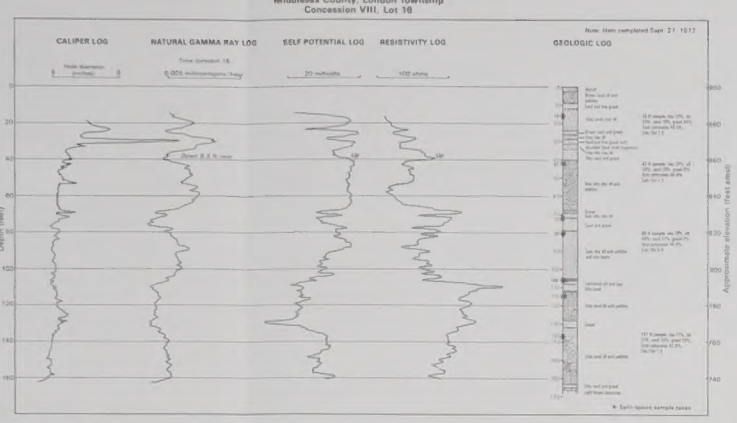


Composite Log of Hole 3552
Middlesex County, Lobo Township
Concession I, Lot 8

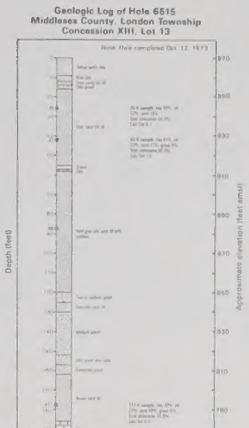




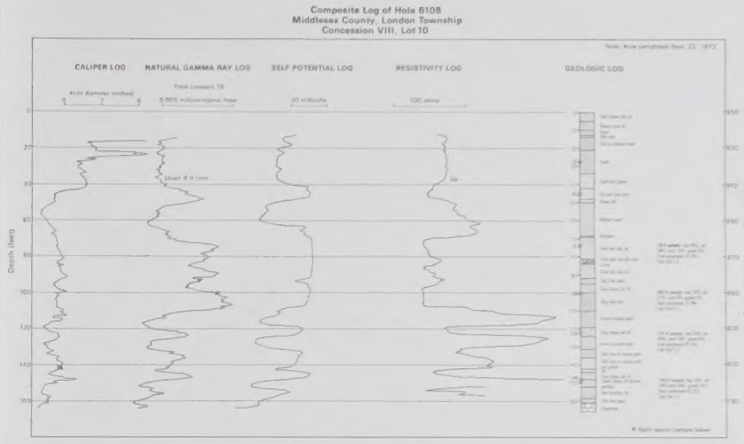
Composite Log of Hole 6107
Middlesex County, London Township
Concession VIII, Lot 16



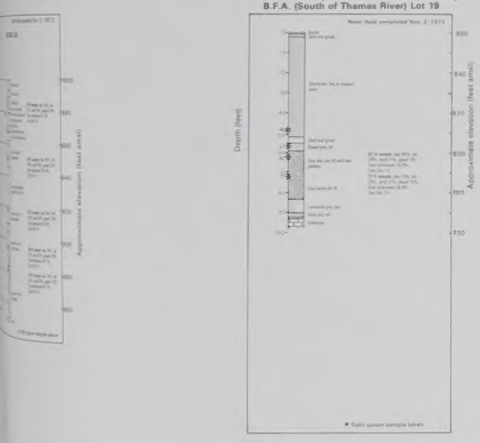
Geologic Log of Hole 6515
Middlesex County, London Township
Concession XIII, Lot 13



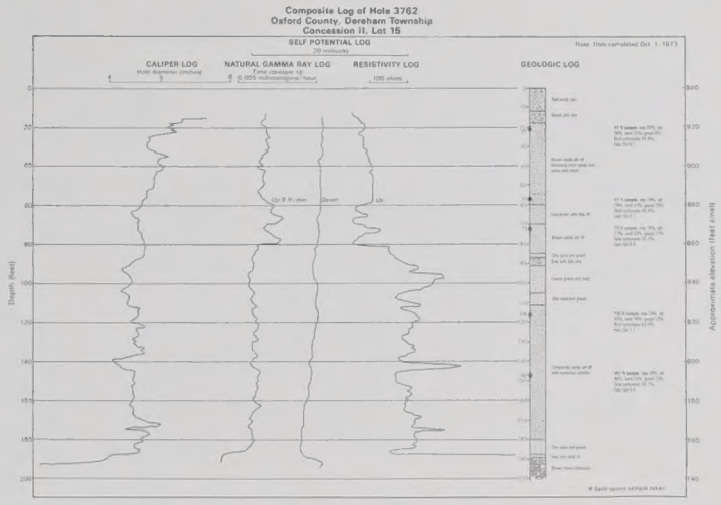
Composite Log of Hole 6108
Middlesex County, London Township
Concession VIII, Lot 10



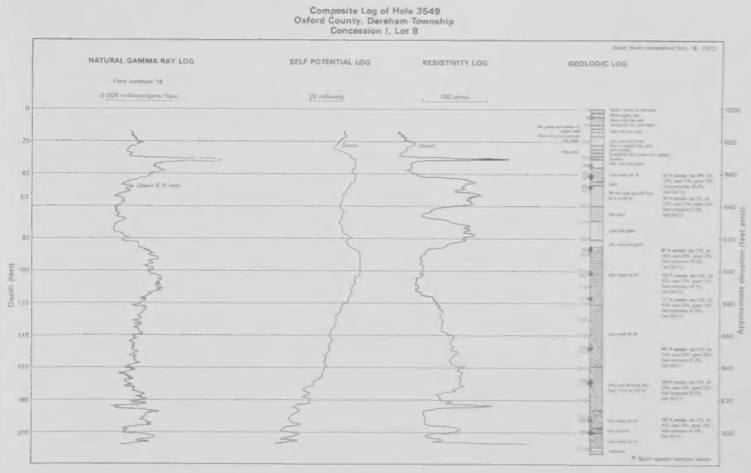
Geologic Log of Hole 6110
Middlesex County, North Dorchester Township
B.F.A. (South of Thames River) Lot 19



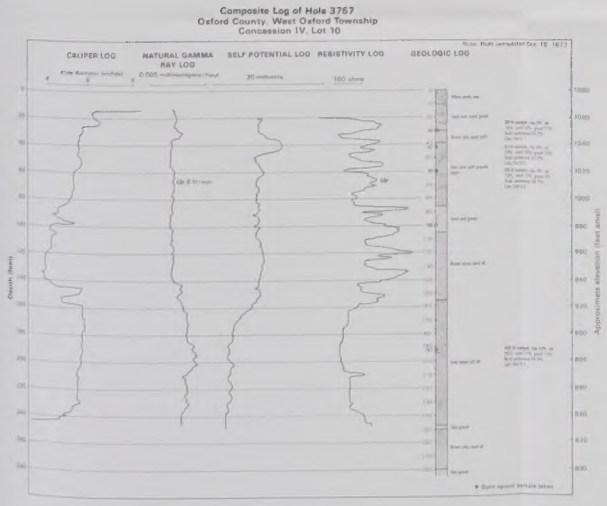
Composite Log of Hole 3762
Oxford County, Dereham Township
Concession II, Lot 15



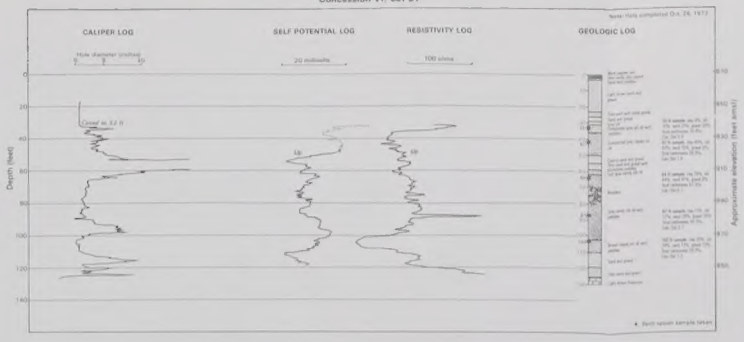
Composite Log of Hole 3549
Oxford County, Dereham Township
Concession I, Lot 8



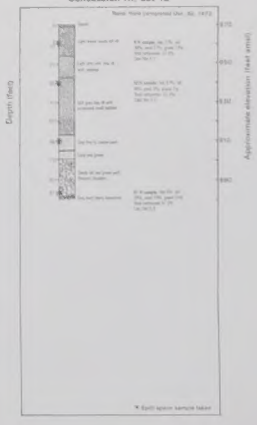
Composite Log of Hole 3767
Oxford County, West Oxford Township
Concession IV, Lot 10



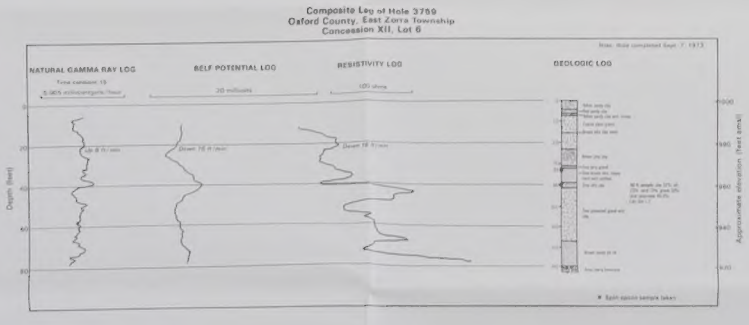
Composite Log of Hole 3550
Oxford County, East Oxford Township
Concession VI, Lot 21



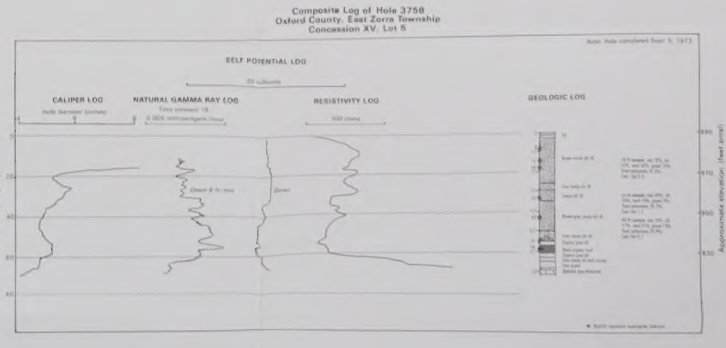
Geologic Log of Hole 3551
Oxford County, East Oxford Township
Concession III, Lot 13

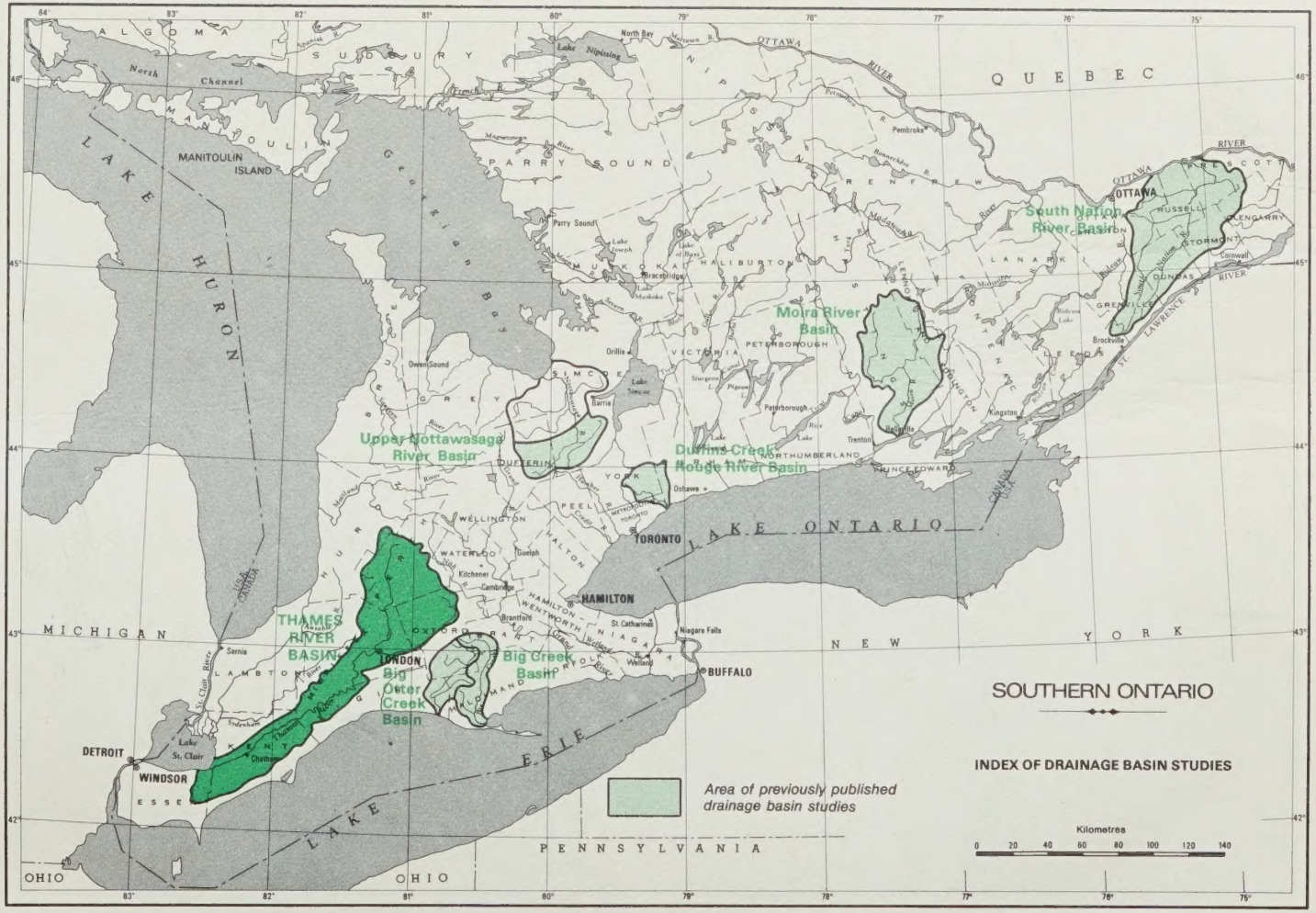


Composite Log of Hole 3759
Oxford County, East Zorra Township
Concession XII, Lot 6



Composite Log of Hole 3758
Oxford County, East Zorra Township
Concession XV, Lot 5




SOUTHERN ONTARIO
INDEX OF DRAINAGE BASIN STUDIES
Area of previously published drainage basin studies
Kilometres
0 20 40 60 80 100 120 140
Upper Nottawasaga River Basin
Moira River Basin
South Nation River Basin
Duffins Creek Rouge River Basin
THAMES RIVER BASIN
Big Otter Creek Basin
Big Creek Basin
LAKE HURON
LAKE ONTARIO
LAKE ERIE
MANITOULIN ISLAND
TORONTO
HAMILTON
BUFFALO
DETROIT
WINDSOR
OTTAWA
QUEBEC
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO